BEFORE THE
FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C.

In the Matter of	)	
	)	
Fourth Annual Report to Congress	)	IB Docket No. 10-99
on the Status of Competition in the Satellite	)	DA 10-1353
Services Industry	)	
	)	
	)	

To: Office of the Secretary

REPLY COMMENTS OF SPACE EXPLORATION TECHNOLOGIES CORP.

Space Exploration Technologies Corp. ("SpaceX"), a domestic launch services provider, submits the following comments in response to The Public Notice of the Federal Communications Commission requests for comments on the Fourth Annual Report to Congress on Status of Competition in the Satellite Services Industry.

I. THIS INQUIRY IS BEYOND THE SCOPE OF THE COMMUNICATIONS SATELLITE ACT OF 1962

SpaceX is pleased to provide information on our launch services and our analysis of the state of the launch market. As a threshold matter, however, it is important to note that the launch industry is not within the scope of the Communications Satellite Act of 1962, as amended (the "Act"). Section 404 of the Act requires the Commission to report to Congress its authorized operations, activities and accomplishments under the Communications Satellite Act, but the statute does not authorize activities or an inquiry into launch services. In fact, the definition of "communications satellite system" in Section 103 of the Act specifically excludes launch services.[1]

[1] *See* 47 U.S.C. § 702(1)("The term "communications satellite system" refers to a system of communications satellites in space whose purpose is to relay telecommunication information between satellite terminal stations, together with such

II. SPACEX LAUNCH SERVICES

SpaceX was founded in 2002 with the overriding goal of increasing the reliability of access to space while significantly decreasing the cost per pound to orbit. In 2008, we became the first commercial company to reach orbit with a privately developed, liquid-fueled launch vehicle, the Falcon 1. The inaugural Falcon 9 launch on June 4, 2010, demonstrated the capability of the world's only current launch vehicle with engine-out capability during boost-phase ascent. SpaceX's commitment to reliability is premised in part on the design choices made so as to eventually carry crew to space—requiring the highest reliability standards.

Developed by SpaceX to provide reliable access to space, both the Falcon 1 and Falcon 9 launch vehicles have received a NASA endorsement with the award of a NASA Launch Services (NLS) contract. Importantly, this contract requires SpaceX to demonstrate reliability of greater than 95%. As part of this NLS award, NASA will be independently certifying the complete Falcon 9 vehicle system and operations.

With more than 1,100 full-time employees, SpaceX possesses deep expertise in propulsion, structures, avionics, safety, quality assurance, mission operations, launch, mission management and systems integration. Reliability has been the primary design driver of the Falcon launch vehicles from inception, and reliability goals have been met largely through simplicity of architecture and the resulting minimization (or even elimination) of possible failure modes. Additionally, SpaceX has designed all of its vehicles—Falcon 1 launch vehicle, Falcon 9 vehicle and Dragon spacecraft (Figure 2)—from the bottom up for ease of manufacturing and testing, while also being within unprecedented cost limits.

---

associated equipment and facilities for tracking, guidance control, and command functions *as are not part of the generalized launching, tracking, control, and command facilities for all space purposes*." (*emphasis added).*

Figure 1: The SpaceX Products Include the Falcon 1 and Falcon 9 Launch Vehicles and Dragon

SpaceX Accomplishments

In only 8 years, SpaceX has demonstrated the capability to design, develop, manufacture, test and successfully fly all the components and subsystems of a launch vehicle, including the engines, structures, avionics, and software. While growing from three employees to over 1,100, SpaceX has undertaken the following:

- Developed, built, tested, and successfully launched the Falcon 9 launch vehicle (Figure 2), demonstrating the ability to deliver large payloads to low Earth orbit, geosynchronous orbit, and destinations beyond. On June 4, 2010, the inaugural flight of the Falcon 9 culminated in a perfect insertion of the second stage and Dragon spacecraft

Figure 2: Falcon 9 Liftoff on June 4, 2010

qualification unit into the target orbit;

- Developed and qualified two flight-proven hydrocarbon boost engines (Merlin 1A and 1C) and three flight-proven hydrocarbon second-stage engines (Merlin Vacuum, Kestrel I and Kestrel II). An upgraded hydrocarbon boost engine (Merlin 1D) is in development;
- Developed, built, tested and successfully launched the Falcon 1, which on September 28, 2008, became the first privately developed, liquid-fueled rocket to achieve Earth orbit. Falcon 1 launched its first commercial payload, RazakSAT, on July 13, 2009, and accurately achieved the targeted mission orbit;
- Developed, built, and tested the Dragon reusable spacecraft as well as critical qualification articles such as remote input/output modules, batteries, nose cone and hypergolic Draco thrusters.
- Developed, built and activated (with range approval) two launch sites for Falcon 1. The Kwajalein facility was designed, built and activated in less than 10 months. SpaceX also developed, built and activated (with range approval) Space Launch Complex 40 at Cape Canaveral in Florida for Falcon 9; and
- Received ISO 9001:2000 quality re-certification in April 2009. The original certification in April 2006 was unprecedented in the aerospace industry, given that it occurred during the system demonstration phase of the product development cycle. During the most recent audit in April 2010, SpaceX was found to be in conformance with ISO 9001:2008 and was recommended for continued certification. SpaceX is also compliant with AS9100.

Launch Vehicle Description

The Falcon 9 is a two-stage vehicle powered by liquid oxygen and rocket-grade kerosene (RP-1). It can transport up to 10,450 kg (23,038 lb) to low-Earth-orbit (LEO). The Falcon 9 is the result of SpaceX's goal to produce an evolved expendable launch vehicle (EELV)-class system with significant

improvements in reliability, cost and responsiveness over existing vehicles. With the Falcon 9, SpaceX adhered to the same design philosophies used in developing the Falcon 1. These include simplicity of architecture and the resulting elimination or minimization of failure modes. The Falcon 9 is designed for robustness and high availability to enable flexible manifests and launch schedules.

Figure3: Nine Merlin Engines Power the First Stage of the Falcon 9 Launch Vehicle

The first stage generates nearly 1 million lb_f (4,448kN) of thrust (sea-level) using nine Merlin engines (Figure 3), and the second stage generates 100,000 lb_f (440 kN) of thrust (vacuum) using a single Merlin Vacuum engine. The Merlin Vacuum engine powers the Falcon 9 second stage with an expansion ratio of 120 and a burn time of 265 sec. For added reliability, the Merlin Vacuum engine has dual-redundant hypergolic igniters with four injection ports. Both stages use thrust vector control for attitude control, and the second stage is capable of multiple restarts on orbit.

By incorporating multiple engines in the vehicle architecture, SpaceX includes the unique reliability feature of propulsion redundancy—a capability offered by no other major launch system. The Falcon 9 has engine-out capability starting early in the first-stage burn. Later in the first-stage burn, the Falcon 9 can tolerate additional engines out. For example, the Falcon 9 nominally shuts down two engines late in the first-stage flight to limit acceleration.

The second-stage tank of the Falcon 9 is a shorter version of the first-stage tank and uses most of the same tooling, material and manufacturing techniques. The common stage design results in

significant cost savings in vehicle production. The second stage also features a reaction control system, which consists of propellant tanks (monomethyl hydrazine and nitrogen tetroxide) that feed the SpaceX-designed Draco thrusters (used for orbit adjustments and deboost of the second stage).

The Falcon 9 second stage is powered by the Merlin Vacuum engine, developed and manufactured by SpaceX. The Merlin Vacuum is capable of up to two restarts in orbit, with coast times limited to a couple of hours. Falcon 9 can place multiple payloads into different orbits, enabling dual-manifest missions and secondary payloads.

The Falcon 9 propellant tank walls and domes are made from aluminum-lithium alloy. SpaceX uses an all friction stir-welded tank—the strongest and most reliable welding technique available. The interstage, which connects the first and second stage and houses the stage separation system, is a carbon fiber structure with an aluminum core composite. Falcon 9 uses a 5.2-m (17 ft) fairing (Figure 4).

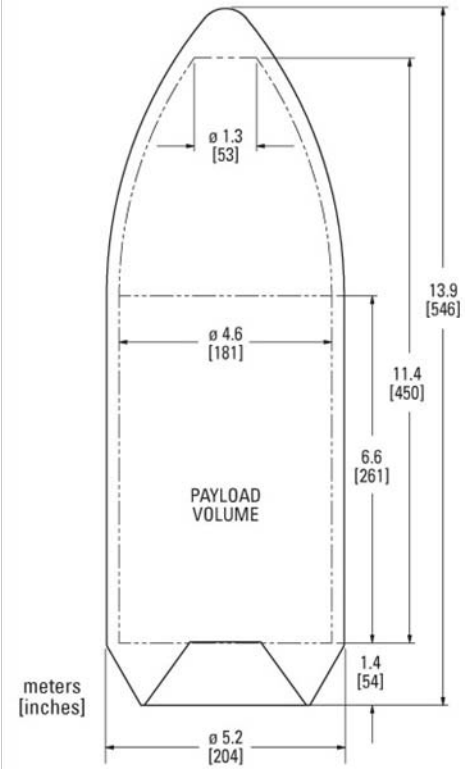


Figure 4: Falcon 9 Fairing and Dimensions

The guidance system takes into account the loss of an engine during first-stage burn and adjusts the targeted trajectory accordingly. This mix of explicit and perturbation guidance schemes was selected in order to generate a smooth, computationally simple trajectory while maintaining orbital insertion accuracies.

The Falcon 9 launch vehicle is equipped with a standard flight termination system to ensure the safety of the public in the event of an anomaly in flight. The system includes two redundant strings of command receivers and decoders, batteries, safe and arm devices, and ordnance. The entire vehicle also has been designed with the aim of meeting human-rating requirements so SpaceX can eventually provide crew transportation services.

Development and Qualification Status

The Falcon 9 launch vehicle successfully reached Earth orbit in its inaugural flight on June 4, 2010. Key technical risks were mitigated by this flight, which included the successful demonstration of—

- Multi-engine ignition.
- Hold down and release for the launch vehicle, including umbilical release.
- First stage performance.
- Stage separation.
- Second-stage engine ignition.
- In-space operation of the second-stage Merlin Vacuum engine.
- Second stage performance.
- Orbit targeting and insertion accuracy.

All primary mission objectives were met, with a nearly perfect insertion of the second stage and Dragon spacecraft qualification unit into a 249.2 km x 253.1 km orbit at 34.49 deg inclination. The

target was a 250 km circular orbit with 34.5 deg inclination. This targeted orbit was subsequently modified by a brief restart of the second-stage engine.

Further, SpaceX gathered important data on vehicle performance and environment. The data is being used in the final preparations for the upcoming NASA demonstration flights and cargo missions to the International Space Station as part of the Commercial Orbital Transportation Services (COTS) and Commercial Resupply Services (CRS) programs.

III. SPACEX IS HELPING THE UNITED STATES REGAIN OF THE GLOBAL LAUNCH MARKET SHARE

Due to government subsidies, many launch providers are able to maintain a dual pricing structure, offering a highly subsidized price to the commercial market. By contrast, SpaceX is committed to pricing its launch vehicles aggressively, with a focus on incremental profit, as opposed to simply setting prices just below the existing competitors. This strategy will help stimulate the commercial market and is attributable in large measure to our investors' long-term focus, which allows the company to spread the cost of research and development over a larger product family.

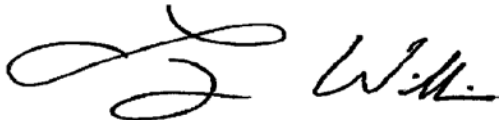
There are only a handful of firms worldwide with the capability to design and build launch vehicles and provide launch services to the entire breadth of the market. The SpaceX Falcon family can serve entire markets, allowing SpaceX to amortize the non-recurring engineering costs over a much broader set of customers. This provides our customers with significantly lower prices.

Despite the importance of space to both the U.S. government and commercial entities (domestic and international), the U.S. launch industry has seen a severe decline in launch rates over the past decade. In the past 5 years only 14% of commercial orbital launches were provided by U.S. companies,

a decline from historical levels.[2] However, as a new entrant, SpaceX is disrupting the market with its significantly lower costs. Though established in 2002, SpaceX operates two brand new launch vehicles, has established an impressive launch manifest, and has been awarded over $2 billion in domestic and international government and commercial contracts, including numerous commercial satellite launches.

Iridium Communications Inc. recently selected SpaceX as a major launch provider. The $492 million contract is the largest single commercial launch deal ever signed and represents a new benchmark in cost-effective satellite delivery to space.[3] SpaceX was in direct competition with several international launch providers to secure this contract and other recent commercial awards.

Respectfully Submitted,



Lawrence H. Williams
Vice President for Strategic Relations
Space Exploration Technologies Corp.

[2] See http://www.thespacereport.org/resources/hardware/comm_orbital_launches.php.
[3] See http://www.spacex.com/press.php?page=20100616.